EXPERT REBUTTAL
OF
BYRON H. SHAW, Ph.D.

TO THE EXPERT REPORT
OF
STEWART W. MELVIN, Ph.D.

Community Association for Restoration of the Environment, Inc.
and Center for Food Safety, Inc.
v.
Cow Palace, LLC, The Dolsen Companies, and Three D Properties, LLC

Docket No. 2:13-cv-3016-TOR

Prepared for:

Law Offices of Charles M. Tebbutt, P.C.
941 Lawrence Street
Eugene, OR 97401

Public Justice
1825 K Street, NW Suite 200
Washington, D.C. 20006

Center for Food Safety, Inc.
303 Sacramento Street, 2nd Floor
San Francisco, CA 94111

This Expert Report contains information designated by Defendants as "CONFIDENTIAL" under the Stipulated Protective Order (ECF No. 82)

1. I, Byron Shaw, have been retained by Plaintiffs in the above-captioned matter to provide expert testimony about the manure management, storage, and application practices of Defendant Cow Palace Dairy, LLC ("Cow Palace" or "Defendant"). As part of this role, I have been asked by Plaintiffs to review and rebut the expert report of Stewart W. Melvin (the "Melvin Report").

2. Scientifically speaking, I agree with the Melvin Report's discussion of the nitrogen cycle at pp. 3-4 of the Report, although I do not believe the cycle to be complicated. To the contrary, the nitrogen cycle has been exhaustively examined by the scientific community, and its various factors and elements are well understood. I do take issue with the figure on page 4, which fails to identify nitrate leaching to groundwater as a part of the nitrogen cycle. The figure only identifies leaching to what appears to be a large surface water body.

3. The Melvin Report begins discussing the use of cow manure at Cow Palace Dairy on Page 5. Melvin states that manure applied to agricultural fields contains nitrogen primarily in the organic nitrogen, ammonium, and ammonia forms, which I agree with. Melvin then opines that nitrogen losses can occur through volatilization in the atmosphere, indicating that losses could be "as high as 25-55% of the nitrogen applied through the irrigation

sprinkler system." I believe that, in the climactic conditions such as those where Cow Palace is situated, the amount of nitrogen losses through volatilization is likely on the lower end of the Melvin Report estimate; that is, in the range of 25-30%. I based this opinion on the fact that the high volatilization rate only applies to ammonia, and much of the manure is applied during cold temperatures in fall, winter and early spring when volatilization is least and at least some of the manure is incorporated shortly after application. Furthermore, I believe the amount of volatilization from Cow Palace's manure spreading trucks would be substantially less than the estimate in the Melvin Report for sprinkler applications, primarily due to the lesser degree of volatilization that occurs when manure is applied only a few feet from the ground, as opposed to being sprayed into the air via a sprinkler system

4. The Melvin Report opines that water may move upward or "wick up" through capillary attraction. In my experience, capillary movement of water is primarily from wet soils into drier soil which would not be likely to occur in agricultural fields that receive large amounts of irrigation and manure applications each season; if anything, this would result in capillary movement downward rather than upward. As such, I do not anticipate seeing any measurable amount of capillary upward transport of nitrate to

occur in Cow Palace's fields. The sampling and evidence I have seen to date also does not demonstrate any type of capillary movement**.**

5. Melvin states that, generally speaking, a farmer will try "to ensure that sufficient water and fertilizer is applied to provide the opportunity for maximum growth; erring on the side of undersupply will be avoided." This approach ignores the environmental consequences that result from too much manure fertilizer being applied to agricultural fields. Even if Cow Palace was trying to maximize crop yields, which it is not the case based on the information I have seen, the Dairy consistently applied far more manure than its crops were capable of using as fertilizer. As a result, it caused manure nutrients to move past crop root zones, where they will become ineffective as fertilizer and eventually discharge to groundwater. At that point, they end up in an aquifer used by members of the public – including CARE members Helen Reddout and Steve Butler – for drinking water.

6. I agree with the Melvin Report's statement that farmers "must over irrigate to some extent in order to drive salts below the root zone where they will not damage plant growth." The reason for this is the salts that are present in irrigation water and in the cow manure that is applied by Cow Palace to its fields. Importantly, when Cow Palace over-irrigates to drive salts below root zones, they are simultaneously causing the excess nitrogen

(in nitrate form) applied to their fields to also migrate below crop root zones, where it becomes ineffective as fertilizer and destined to reach groundwater.

7. Melvin agrees with me that excess nitrate that moves below crop root zones cannot be used as fertilizer, and that such nitrate will eventually reach groundwater with subsequent additions of moisture (e.g., through additional irrigation, precipitation, snowmelt, and manure applications). I disagree that any significant amount of nitrate can move upward in the soil profile with capillary attraction; I have seen absolutely no soil sampling that would support such a claim, and the Melvin Report makes no specific references to any physical testing to support this conclusion.

8. The Melvin Report claims that, where "native desert soils have never been irrigated and the groundwater table is deep (>80-100 ft) below the ground surface, it has been shown that little if any movement of water from the root zone is percolated to the groundwater table." It goes on to assert that, in the Yakima Valley, "an arid area, the velocity of downward movement is controlled by the unsaturated conductivity of the soil which various with soil type and moisture content of the unsaturated soils." The Melvin Report thus suggests that, because Cow Palace Dairy's application fields are located in an area that is traditionally arid, no percolation to groundwater will occur. I disagree. Cow Palace's fields have received

substantial amounts of irrigation water and liquid manure for the past four decades – perhaps longer. In these situations, the "native desert soils" are no longer characteristic of "desert soils" because they have been transformed through irrigation. This history of irrigation means that soil moisture levels throughout the soil profile are artificially high, allowing for the vertical movement of water from the surface to the aquifer. Indeed, based on both the soil and groundwater sampling results I have seen, it is evident that there is some degree of vertical flow through the soil matrix and into groundwater. A USGS study of the Yakima area found that even under non-irrigated conditions there was about 1 inch of groundwater recharge and with irrigation there has been a large increase in groundwater recharge. In fact, USGS has found that as a result of over irrigation in the irrigated parts of the Yakima Valley that groundwater recharge has exceeded groundwater pumpage by over 20 feet between 1960 and 2001. Vaccaro, J., *River-aquifer exchanges in the Yakima River basin*, Washington; U.S. Geological Survey Scientific Investigations Report 2011-5026, 2011.

9. The Melvin Report seems to acknowledge this point, admitting that "where water is supplied by irrigation or small areas of flow concentrations will there be sufficient soil moisture in the deep soil profile to allow significant water migration downward to the water table." However, Melvin

goes on to state that the vadose zone in the area of Cow Palace is quite deep, as much as 100 feet below ground surface. I question whether Dr. Melvin had reviewed all of the groundwater data obtained from the area around Cow Palace, which shows that the water table is as shallow as 32 ft. at DC-04. Furthermore, the Melvin Report states that any type of dry soil found within this 100 feet gap would act as a "restricting layer to minimize deep percolation of water to the groundwater table." Dr. Melvin cites no physical data or sampling to support this conclusion. I would not expect, given the history of use at this site, to find areas of soil between the bottom of the root zone and the top of the water table that would be sufficiently dry to act as a restricting layer. The soil would need to be exceptionally dry, and considering the long history of irrigation and manure applications at this site, those conditions are extremely unlikely to exist today. Dr. Melvin fails to discuss or recognize the widely accepted occurrence of preferential flow of water in the vadose zone, which I covered in my expert report.

10. The Melvin Report states that Cow Palace's DNMP estimates that, if Cow Palace applied all of its manure to its fields, and the crops removed the estimated amount of nutrients as fertilizer, as identified by the DNMP, there would be an annual deficit of 161,754 lbs. of nitrogen and an annual surplus of 64,172 lbs. of phosphorus. If this were correct, then I would expect to see

Cow Palace applying artificial nitrogen fertilizer to their fields and for the residual soil nitrogen samples to be consistently low, which they are not. The Report cites Table 4A for this conclusion. That table, found at COWPAL000035, assumes that the Dairy's manure water would have a nitrogen content of 1.51 lbs./1000 gallons, which I believe is a very low estimate for cow manure. The table estimates, based on generic numbers, that Cow Palace's herd (assumed size is 10,640 animals) would produce 551,471 lbs. of nitrogen per year. It then estimates the amount of losses that would occur: "0.60" for storage loss, "0.70" for volatilization loss, "0.85" for denitrification, and another "0.60" for some other reduction that is not identified. In other words, the DNMP estimates that 40% of the nitrogen is removed through the settling basins, 30% of what remains is reduced through volatilization, another 15% of that is lost through denitrification, and then a final 40% loss due to some unidentified mechanism. I do not find these estimates credible or accurate, especially the unidentified, 40% reduction and the additional 15% for denitrification, which is extremely unlikely to occur given the soils found in and around Cow Palace.[1]

11. Furthermore, the Melvin Report's reliance on Table 4A is misplaced. The DNMP lays out exactly what Cow Palace should do to determine

[1] COWPAL000036.

agronomic application rates. First, the DNMP explains the characteristics of the three primary nutrients found in cow manure: nitrogen, phosphorus, and potassium. COWPAL0000015. It explains why careful management of these nutrients is important to the environment, especially for nitrogen, "which has the greatest pollution potential of the three elements, and generally limits the amount of manure that can be safely applied." *Id*. Second, the DNMP discusses the crops grown at Cow Palace and their respective nutrient needs, cautioning the dairy operator that "[w]hen determining agronomic rates for manure application, it is important to choose achievable yield goals…[a]verage yields for the past three to five years for each field should be used." *Id*. As to the specific crop removal rates identified, the DNMP further cautions that "**these are guidelines only"** and that "**farmers should vary timing and amounts of application depending on particular soil, crop type, and crop needs and weather conditions."** *Id*. (emphasis in original)

12. The DNMP next describes that it is "**required**" for Cow Palace to "test the nutrient residuals in the soil along with nutrient content testing of the storage ponds and dry manure before application." This important third step informs the Dairy about how much nutrients, such as nitrogen, are already in the soil and available for plants as fertilizer. It also instructs the

Dairy about the importance of knowing the manure's nutrient content, which must be determined before calculating agronomic application rates. *See also* COWPAL0000016 (identifying testing requirements and explaining, again in red emphasized lettering, that the dairy must "test the nutrient residuals in the soil along with nutrient content of the liquid in the storage ponds and the solid (dry) manure **before** land application[.]"

13. The DNMP further explains the importance of determining the moisture content of the soil before applying manure, COWPAL000018-19; the soil infiltration rates of the Warden Silt and Scoon Silt series soils; COWPAL0000019; the need to vary the timing of manure applications to crop needs; COWPAL000018; and, perhaps most importantly, making it clear that "[t]otal nutrient quantities must not exceed the amount that can be used by the crop being grown." *Id.*

14. Thus, the Melvin Report is simply wrong when it opines that the DNMP informs Cow Palace that it should not expect a buildup of excessive nitrogen "even if the Dairy applied all of its liquid manure to its available fields." Quite the opposite, the DNMP tells Cow Palace how to calculate an agronomic application rate using data it was meant to timely obtain before applying any manure. It may have contained estimates for Cow Palace to originally use, but throughout the body of the document it makes clear that

application rates are meant to be varied based on the required data. This Cow Palace never did.

15. The Melvin Report admits that Cow Palace failed to use critical data in determining an agronomic application rate: the nutrient content of the manure to be applied. Instead, Dr. Melvin acknowledges that Cow Palace used a generic, 1.5 lbs./1000 gallon figure, in violation of the Dairy's DNMP and accepted agricultural practices.

16. After admitting this mistake, the Report examines one of the Dairy's "summary spreadsheets" for Field 2, from the 2013 crop year. I opined in my Expert Report that these spreadsheets are not a proper method of nutrient budgeting, for they fail to take into account the residual soil nitrogen levels, the average of the past three to five years' crop yields, any nutrient credits for past alfalfa crops, any nutrient credits for soil organic matter contributions, and based nutrient needs on the unrealistic crop removal rates found in the DNMP. In light of these shortcomings, all but one of which would have been rectified by a short read of the DNMP's requirements, I do not believe these records are capable of demonstrating agronomic application rates.

17. Nonetheless, Dr. Melvin uses these spreadsheets to determine that Cow Palace's manure applications never exceeded crop needs in Field 2. In

reaching this point, the Melvin Report relies upon and adopts a methodology that would never survive scientific scrutiny. Dr. Melvin compared the gross application of nitrogen to Field 2 in 2014 (503 lbs./ac, according to his report) against the estimated crop removal rates from the DNMP (250 lbs./ac for triticale; 250 lbs./ac corn silage). Because those numbers are fairly close (503 vs. 500), he assumes that the applications must have been agronomic. This analysis ignores a plethora of information that is critical to determining whether an application was agronomic, such as: residual nutrients in the soil; timing of application; timing of seeding; weather conditions at time of application; actual crop removal rate based on past years crop yields; and contributions from other sources of nitrogen, such as organic matter mineralization. One cannot simply compare gross application against estimated **maximum** crop yields and reasonably conclude that all applications were agronomic; indeed, by failing to look at *any* post-harvest soil samples, Dr. Melvin ignores one of the most fundamental aspects of agronomy and nutrient budgeting. In fact, the pre-plant soil test completed by Cow Palace on May 14, 2014 showed that Field 2 had 102 lbs./ac nitrate in the top foot, 113 lbs./ac in the second foot, and 115 lbs./ac in the third foot, for a total of 340 lbs./ac available nitrate in the top three foot of the soil column. If Cow Palace applied 503 lbs./ac nitrogen *after* this test result, as

the Melvin Report states for year 2014, then it plainly applied far more manure than the crop could possibly remove as fertilizer.

18. But the Melvin Report takes this flawed methodology one step further. Dr. Melvin goes on to look at the *average* application rate on Field 2 over a five-year period. He finds that there was an annual gross average application rate of 348 lbs./ac to Field 2, "less than the recommended fertilizer values of 250 lb/a for the triticale and 250 lbs/a for the corn silage grown over each of those years." This opinion does not withstand scientific scrutiny, let alone common sense. The averaging of application rates fails to consider the timing of those applications, the amount of residual nutrients found in the soil that would already be available to crops for fertilization, organic matter mineralization, manure carryover from past years, soil moisture levels, crop yields, and weather conditions. In fact, it ignores nearly every facet that the DNMP instructs Cow Palace to consider when making manure applications.

19. Dr. Melvin goes on to apply this methodology to Field 1, finding that Cow Palace applied 296 lbs./ac nitrogen on average over the past five years, which he opines is "significantly less than the recommended fertilizer rate of 480 lbs/ac for alfalfa…and 500 lbs/ac for triticale and corn silage." He then states that the gross annual application rate for all of Cow Palace's other

fields average at or below 282 lbs./acre. Again, Dr. Melvin fails to look closely at each application, ignoring data which plainly demonstrates that Cow Palace's manure applications exceeded crop removal rates, when taking into account all of the information required by the DNMP to be considered by the Dairy. *See* discussion in Expert Report of Byron H. Shaw at ¶¶ 33-159.

20. In reaching his conclusion that Cow Palace applied less nutrients than what the DNMP estimated crops would remove from the soil, Dr. Melvin fails to discuss the history of high post-harvest soil samples obtained from Cow Palace's fields. If the Melvin Report's methodology were accurate, then I would not anticipate seeing much, if any, residual nitrate in Cow Palace's fields. But that is not the case, as discussed at length in my expert report. Instead, each of Cow Palace's fields shows a long history of high post-harvest soil sample results, frequently followed by additional, non-agronomic applications of manure. At no point in time does Dr. Melvin address these soil samples, which thoroughly debunk his theory and methodology.

21. The Melvin Report states that average crop yields for 2009-2013 were 10.3 tons/ac for sudan grass, 7.95 tons/ac for triticale, 15.5 tons/ac for haylage, and 32 tons/ac for corn silage, and that these yields are excellent,

suggesting that Cow Palace's manure applications must have been agronomic to achieve such a result. These numbers do not reflect the data I was provided and do not identify the moisture content of the harvested crops which is needed to estimate nutrient removal. Below is a chart that summarizes Cow Palace's crop yields for the period 2009-2014 based on the information produced by the Dairy.

Cow Palace crop yields (listed in tons/acre)									
	2009	2010	2011	2012	2013	2014	Average	DNMP anticipated crop yields	DNMP expected N removal rates (pounds/acre)
Field 1						See note on COWPAL015760			
Sudan grass	8.3	n/a	n/a	n/a	n/a	n/a	8.3	8	325
Triticale	10.2	n/a	n/a	n/a	6.2	6.53	7.643333333	10	250
Haylage	n/a	17.3	14.1	13.7	n/a	n/a	15.03333333	8	480
Corn	n/a	n/a	n/a	n/a	24.6	not yet harvested	24.6	30	250
Field 2									
Sudan grass	9.3	9.2	17	8.3	n/a	n/a	10.95	8	325
Triticale	n/a	6.9	10.6	8.8	6.8	6.77	7.974	10	250
Haylage	3.9	n/a	n/a	n/a	n/a	n/a	3.9	8	480
Corn	n/a	n/a	n/a	n/a	29.8	not yet harvested	29.8	30	250
Field 3									
Triticale	3.8	n/a	n/a	n/a	5.4	4.58	4.593333333	10	250
2-cut Haylage	5.2	n/a	n/a	n/a	n/a	n/a	5.2	8	480
Haylage	n/a	14.2	12	15.4	n/a	n/a	13.86666667	8	480
Corn	n/a	n/a	n/a	n/a	n/a	not yet harvested	n/a	30	250
Corn* Drier 25-28%	n/a	n/a	n/a	n/a	24.6	n/a	24.6	30	250
Field 4A									
Corn	36.3	37.8	36.8	32.1	n/a	not yet harvested	35.75	30	250
3-cut Haylage	n/a	n/a	n/a	n/a	8.2	16.19	12.195	8	480
Triticale	n/a	n/a	n/a	n/a	10.3	n/a	10.3	10	250
Field 4B									
2-cut Haylage	6.6	n/a	n/a	n/a	n/a	n/a	6.6	8	480
Triticale	6.3	n/a	n/a	10.1	n/a	n/a	8.2	10	250
Haylage	n/a	14.8	15.9	n/a	n/a	n/a	15.35	8	480
Sudan grass	n/a	n/a	n/a	9.9	n/a	n/a	9.9	8	325

3-cut Haylage	n/a	n/a	n/a	n/a	7.8	11.35	9.575	8	480
Field 5									
Corn	28.7	n/a	n/a	n/a	n/a	not yet harvested	28.7	30	250
3-cut Haylage	n/a	12.9	n/a	n/a	n/a	9.19	11.045	8	480
Triticale	n/a	6.9	n/a	n/a	n/a	n/a	6.9	10	250
Haylage	n/a	n/a	22.6	17.7	18.9	n/a	19.73333333	8	480
Field 6									
Triticale	n/a	n/a	n/a	n/a	7.6	5.66	6.63	10	250
Corn	28.4	34.3	27.4	25.9	28.6	not yet harvested	28.92	30	250

"n/a" indicates that the crop was not reported as being planted in a particular field for the given crop year

22. First, I disagree that Cow Palace's crop yields have been excellent. For instance, using the Melvin Report figures, Cow Palace's triticale yield is below the 10 tons/ac estimate identified by the DNMP as requiring 250 lbs./ac nitrogen. COWPAL000035. This means that Cow Palace's triticale crop likely has not been using anywhere close to 250 lbs./ac nitrogen, as I explained numerous times in my expert report. When looking to the specific results for each field, it becomes even more evident that many of Cow Palace's yields have been poor, especially for triticale. *See, e.g.*, results for Field 3 triticale yield, *supra*. Second, high crop yields are not synonymous with agronomic application rates. The Dairy can and, as shown in my expert report, has applied more manure to its fields than its crops could uptake as fertilizer. Consequently, Cow Palace's crops are receiving large amounts of nitrogen, *some of which* will be used as fertilizer and *much of which* will not be capable of being used. The unused portion will migrate further into the soil column with subsequent application, irrigation, precipitation, and snowmelt, pushing excess nitrogen (in nitrate form) toward groundwater. Third, crop yield data produced by Cow Palace to the Plaintiffs are lower than what appears to be reported in the Melvin Report. *See, e.g.*, COWPAL009394 (2009 crop yield summaries) (Field 1, poor sudan grass yield; Field 2, poor haylage yield; Field 3, poor triticale yield; Field 4B, poor

triticale yield). Dr. Melvin provides no insight or documentation into his methodology for determining average crop yields.

23. Dr. Melvin states that he reviewed records of soil tests conducted "over the last several years on the Cow Palace feed crop fields." Based on those tests, he does not believe there were any over-applications of manure. In reaching this conclusion, which I disagree with, the Melvin Report adopts another flawed methodology that is neither scientifically accepted nor supportable. Dr. Melvin takes the position that, because Cow Palace's DNMP estimates that the Dairy could apply all of its manure to its fields and still have a nitrogen deficit, if any over-applications did occur, then there would have to be a slow rise in phosphorus levels in the first foot of the soil column in all of Cow Palace's fields.

24. As a primary matter, this theory completely ignores the fact that high nitrate levels have been observed in Cow Palace's fields, both through the Dairy's own sampling and through Plaintiffs' own deep soil sampling, which showed high levels of nitrate in the soil column below crop root zones (Dr. Melvin completely ignores these sampling results in his report). It also fails to take into account the deeper phosphorus results found at the two-foot depth in the soil column.

25. This theory also ignores the fact that the phosphorus levels in Cow

Palace's fields are also excessively high. The Oregon State Extension Service, EC 1478, has identified a soil phosphorus level of 50 parts per million or "ppm" in the top foot of the soil column as excessive for agricultural fields located east of the Cascades. Here, the vast majority of Cow Palace's soil tests have results higher than this figure – in some instances, Cow Palace's residual phosphorus levels are more than triple this figure in the top foot alone. If one considers the levels found in the second and third feet, then the conclusion that Cow Palace over-applied manure to its fields becomes inescapable.

26. Moreover, Dr. Melvin does not calculate what the phosphorus removal rate was for each crop planted on Cow Palace's fields. It will be expected that some phosphorus will be removed as fertilizer by the active crop, even if excessive amounts of nitrogen and phosphorus were applied to the field.

27. In addition, not all of the excessive phosphorus applied to the soils will show up in the soil tests used to estimate the amount of soil phosphorus available for plants. Some of the excess phosphorus will react with soil minerals, especially calcium, to become unavailable and likely will not be fully accounted for in soil tests reports. Both soil pH and calcium levels are high in these soils, indicating that much of the excess application will not be

completely reflected in the soil tests.

28. Additionally, I believe that there is some phosphorus loss in the soil due to runoff from the fields. Phosphorus can be transported off application fields when there is runoff, either from manure applications that are too heavy or from having too much irrigation water applied to a field – something that Cow Palace does to push salts deeper into the soil column. When this occurs, phosphorus will move off the field and into either some of Cow Palace's tailwater recovery ponds or nearby irrigation ditches. In fact, Plaintiffs' own water quality sampling of the "Catch Basin" on October 30, 2013 showed high levels of phosphorus results: 4.51 mg/L total phosphorus. These results are high for a water quality sample, indicating substantial runoff from the fields.

29. Finally, some excess phosphorus applied by Cow Palace also likely was pushed deeper into the soil column through leaching, plowing or tilling of Cow Palace's fields.

30. In conclusion, Dr. Melvin agrees with me and Plaintiffs that Cow Palace failed to abide by their DNMP in calculating agronomic rates and, in some instances, applied more manure than was necessary. Beyond those points, I disagree with Dr. Melvin's flawed methodology of "averaging" gross application amounts and comparing those against estimated crop

removal rates, which ignores critical data. I also disagree with Dr. Melvin's methodology and theory that, if over-applications took place, then phosphorus levels *must* show an increasing trend from year to year. The phosphorus levels observed in Cow Palace's fields are consistently excessively high – in some instances, many times higher than the 40 ppm level established as being "excessive" – demonstrating that Cow Palace has indeed made applications without regard to agronomic need. That the Melvin Report ignores the broad universe of evidence of Cow Palace's over-applications, including consistently high soil phosphorus, nitrate, and potassium tests, Cow Palace's admitted shortcomings in following its DNMP, and Plaintiffs' own deep soil sampling, demonstrates just how flawed Dr. Melvin's conclusions are in this case.

Dated: October 20, 2014.

Byron H. Shaw, Ph.D.
Professor Emeritus, Water Resources
University of Wisconsin, Stevens Point